

## CLAIMS

1. A packet communication system comprising:
  - a plurality of terminal equipments that conduct communication operation at periodic timing; and
  - 5 relay equipments that relay packets transmitted between said terminal equipments, wherein synchronization control packets for timing synchronization are transmitted between adjacent equipments to thereby establish synchronization of operation timing,
- 10 each of said terminal equipments and relay equipments including,
  - a synchronization request unit which transmits a synchronization request packet to an adjacent equipment at own operation timing and thereby performs a synchronization request;
  - 15 a synchronization response unit which is responsive to acceptance of a synchronization request packet from said adjacent equipment, for transmitting a synchronization response packet corresponding to the synchronization request packet according to own synchronization timing and thereby conducting a synchronization response;
  - 20 a calculation unit which calculates a synchronization deviation value with respect to an adjacent equipment on the basis of a time difference between an arrival time of the synchronization response packet transmitted from said
  - 25

5

2. The packet communication system according to claim 1, wherein each of said terminal equipments comprises an information packet transmission unit which transmits information packets having a number and a length predetermined for each terminal equipment toward an opposite terminal equipment in the wake of the synchronization request or response, and each of said relay equipments comprises a storage unit which temporarily stores information packets received between the current operation timing and next operation timing; and a relay unit which relays information packets stored in said storage unit in the wake of the synchronization request or response packet at next operation timing.

10 3. The packet communication system according to claim 2, wherein each of said relay equipments further comprises an extraction unit which extracts only data portions of information packets received between current operation timing and next operation timing, when relaying information packets from an N side route of a 1:N multiplexing and

15

20

25

broadcasting communication system to a 1 side route; and a packet generation unit which generates packets having data portions extracted by said extraction unit and arranged in a predetermined order, and

5       said relay unit relays packets generated by said packet generation unit in the wake of the synchronization request or response packet at next operation timing.

4.       The packet communication system according to claim  
10 1, wherein said terminal equipments and relay equipments have a same synchronization timing number that increases by 1 every operation timing according to timing synchronization control, and each of said terminal equipments transmits packets having a number and a length  
15 predetermined for each terminal equipment toward an opposite terminal equipment in the wake of the synchronization request or response at operation timing specified by a synchronization timing number predetermined for each terminal equipment.

20

5.       The packet communication system according to claim  
1, wherein each of said terminal equipments and relay equipments transmits an equipment management packet for notification and collection of failure information and  
25 update of initial setting parameters and operation programs

of respective equipments, toward an adjacent equipment in the wake of the synchronization request or response packet according to a length and a number predetermined for each of said terminal equipments and relay equipment.

5

6. The packet communication system according to claim 1, wherein each of said terminal equipments has packets of best effort type that are retransmitted by a communication procedure of a higher order layer even if said packets have 10 been discarded because of system congestion, as nonpreferential information packets; when there is a time for transmitting information packets of a maximum length in an interval between transmission of an information packet and next operation timing, each of said terminal equipments 15 transmits said nonpreferential information packets; and when there is a time required for transmission of information packets of a maximum length in an interval between relay and next operation timing, each of said relay equipments relays said nonpreferential information packets.

20

7. The packet communication system according to claim 1, wherein each of said relay equipments further comprises a detection unit which detects an error of a timing synchronization procedure or an excess of the number of 25 information packets between said relay equipment and an

adjacent equipment; and a relay stoping unit which is responsive to detection of an error of a timing synchronization procedure or an excess of the number of information packets conducted by said detection unit, for 5 stopping the relay of information packets until said error of a timing synchronization procedure or excess of the number of information packets is canceled.

8. A packet communication method applicable to a packet 10 communication system, said packet communication system including a plurality of terminal equipments that conduct communication operation at periodic timing; and relay equipments that relay packets transmitted between said terminal equipments, wherein synchronization control 15 packets for timing synchronization are transmitted between adjacent equipments to thereby establish synchronization of operation timing, the packet communication method comprising:

a synchronization request step at which each of said 20 terminal equipments and relay equipments transmits a synchronization request packet to an adjacent equipment at own operation timing and thereby conducting a synchronization request;

a synchronization response step at which, in response 25 to acceptance of a synchronization request packet from said

adjacent equipment, each of said terminal equipments and relay equipments transmits a synchronization response packet corresponding to the synchronization request packet according to own synchronization timing and thereby conducts  
5 a synchronization response;

a calculation step at which each of said terminal equipments and relay equipments calculates a synchronization deviation value with respect to an adjacent equipment on the basis of a time difference between an arrival  
10 time of the synchronization response packet transmitted from said adjacent equipment and own operation timing; and

a correction step at which each of said terminal equipments and relay equipments corrects operation timing of the own equipment on the basis of the synchronization  
15 deviation value calculated at the calculation step.

9. The packet communication method according to claim  
8, further comprising:

an information packet transmission step at which each  
20 of said terminal equipments transmits information packets having a number and a length predetermined for each terminal equipment toward an opposite terminal equipment in the wake of the synchronization request or response; and

a relay step at which each of said relay equipments  
25 temporarily stores information packets received between the

current operation timing and next operation timing, and relays information packets temporarily stored in said storage unit in the wake of the synchronization request or response packet at next operation timing.

5

10. The packet communication method according to claim 9, further comprising an extraction step at which each of said relay equipments extracts only data portions of information packets received between current operation 10 timing and next operation timing, when relaying information packets from an N side route of a 1:N multiplexing and broadcasting communication system to a 1 side route; and a packet generation step at which each of said relay equipments generate packets having data portions extracted 15 at said extraction step and arranged in a predetermined order, and

at the relay step, packets generated at the packet generation step are relayed in the wake of the synchronization request or response packet at next operation timing.

11. The packet communication method according to claim  
8, wherein said terminal equipments and relay equipments  
have a same synchronization timing number that increases  
25 by 1 every operation timing according to timing

5 synchronization control, and each of said terminal equipments transmits packets having a number and a length predetermined for each terminal equipment toward an opposite terminal equipment in the wake of the synchronization request or response at operation timing specified by a synchronization timing number predetermined for each terminal equipment.

12. The packet communication method according to claim 10 8, wherein each of said terminal equipments and relay equipments transmits an equipment management packet for notification and collection of failure information and update of initial setting parameters and operation programs of respective equipments, toward an adjacent equipment in 15 the wake of the synchronization request or response packet according to a length and a number predetermined for each of said terminal equipments and relay equipment.

13. The packet communication method according to claim 20 8, wherein each of said terminal equipments has packets of best effort type that are retransmitted by a communication procedure of a higher order layer even if said packets have been discarded because of system congestion, as nonpreferential information packets; when there is a time 25 for transmitting information packets of a maximum length

in an interval between transmission of an information packet and next operation timing, each of said terminal equipments transmits said nonpreferential information packets toward opposite terminal equipment; and when there is a time required for transmission of information packets of a maximum length in an interval between relay and next operation timing, each of said relay equipments relays said nonpreferential information packets.

10 14. The packet communication method according to claim  
8, further comprising:

a detection step at which each of said relay equipments  
detects an error of a timing synchronization procedure or  
an excess of the number of information packets between said  
15 relay equipment and an adjacent equipment; and

a relay stop step at which, in response to detection of an error of a timing synchronization procedure or an excess of the number of information packets at said detection step, each of said relay equipments stops the relay of information packets until said error of a timing synchronization procedure or excess of the number of information packets is canceled.

15. A computer readable recording medium wherein a packet communication method of a packet communication system is recorded thereon as a computer program for making a computer execute a packet communication method applicable to a packet 5 communication system, said packet communication system including a plurality of terminal equipments that conduct communication operation at periodic timing; and relay equipments that relay packets transmitted between said terminal equipments, wherein synchronization control 10 packets for timing synchronization are transmitted between adjacent equipments to thereby establish synchronization of operation timing, the packet communication method comprising:

15 a synchronization request step at which each of said terminal equipments and relay equipments transmits a synchronization request packet to an adjacent equipment at own operation timing and thereby conducting a synchronization request;

20 a synchronization response step at which, in response to acceptance of a synchronization request packet from said adjacent equipment, each of said terminal equipments and relay equipments transmits a synchronization response packet corresponding to the synchronization request packet according to own synchronization timing and thereby conducts 25 a synchronization response;

a calculation step at which each of said terminal equipments and relay equipments calculates a synchronization deviation value with respect to an adjacent equipment on the basis of a time difference between an arrival time of the synchronization response packet transmitted from said adjacent equipment and own operation timing; and

5 a correction step at which each of said terminal equipments and relay equipments corrects operation timing of the own equipment on the basis of the synchronization deviation value calculated at the calculation step.

0

16. A computer readable recording medium wherein a packet communication method of a packet communication system is recorded thereon as a computer program for making a computer 15 execute a packet communication method applicable to a packet communication system, said packet communication system including a plurality of terminal equipments that conduct communication operation at periodic timing; and relay equipments that relay packets given and received between 20 said terminal equipments, wherein synchronization control packets for timing synchronization are transmitted between adjacent equipments to thereby establish synchronization of operation timing, the packet communication method comprising:

terminal equipments and relay equipments transmits a synchronization request packet to an adjacent equipment at own operation timing and thereby conducting a synchronization request;

5 a synchronization response step at which, in response to acceptance of a synchronization request packet from said adjacent equipment, each of said terminal equipments and relay equipments transmits a synchronization response packet corresponding to the synchronization request packet  
10 according to own synchronization timing and thereby conducts a synchronization response;

a calculation step at which each of said terminal equipments and relay equipments calculates a synchronization deviation value with respect to an adjacent equipment on the basis of a time difference between an arrival time of the synchronization response packet transmitted from  
15 said adjacent equipment and own operation timing; and

a correction step at which each of said terminal equipments and relay equipments corrects operation timing  
20 of the own equipment on the basis of the synchronization deviation value calculated at the calculation step;

an information packet transmission step at which each of said terminal equipments transmits information packets having a number and a length predetermined for each terminal  
25 equipment toward an opposite terminal equipment in the wake

of the synchronization request packet; and

a relay step at which each of said relay equipments temporarily stores information packets received between the current operation timing and next operation timing, and  
5 relays the temporarily stored information packets in the wake of the synchronization request packet at next operation timing.

17. A computer readable recording medium wherein a packet  
10 communication method of a packet communication system is recorded thereon as a computer program for making a computer execute a packet communication method applicable to a packet communication system, said packet communication system including a plurality of terminal equipments that conduct  
15 communication operation at periodic timing; and relay equipments that relay packets given and received between said terminal equipments, wherein synchronization control packets for timing synchronization are transmitted between adjacent equipments to thereby establish synchronization  
20 of operation timing, the packet communication method comprising:

a synchronization request step at which each of said terminal equipments and relay equipments transmits a synchronization request packet to an adjacent equipment at  
25 own operation timing and thereby conducting a

synchronization request;

a synchronization response step at which, in response to acceptance of a synchronization request packet from said adjacent equipment, each of said terminal equipments and relay equipments transmits a synchronization response packet corresponding to the synchronization request packet according to own synchronization timing and thereby conducts a synchronization response;

10 a calculation step at which each of said terminal equipments and relay equipments calculates a synchronization deviation value with respect to an adjacent equipment on the basis of a time difference between an arrival time of the synchronization response packet transmitted from said adjacent equipment and own operation timing; and

15 a correction step at which each of said terminal equipments and relay equipments corrects operation timing of the own equipment on the basis of the synchronization deviation value calculated at the calculation step;

an information packet transmission step at which each  
20 of said terminal equipments transmits information packets  
having a number and a length predetermined for each terminal  
equipment toward an opposite terminal equipment in the wake  
of the synchronization request packet; and

a relay step at which each of said relay equipments  
25 temporarily stores information packets received between the

current operation timing and next operation timing, and relays the temporarily stored information packets in the wake of the synchronization request packet at next operation timing;

5        an extraction step at which each of said relay equipments extracts only data portions of information packets received between current operation timing and next operation timing, when relaying information packets from an N side route of a 1:N multiplexing and broadcasting 10 communication system to a 1 side route; and

      a packet generation step at which each of said relay equipments generate packets having data portions extracted at said extraction step and arranged in a predetermined order,

15        wherein, at the relay step, packets generated at the packet generation step being relayed in the wake of the synchronization request packet at next operation timing.